INTERNATIONAL CODE COUNCIL®

People Helping People Build a Safer World™

I-Code Requirements for Hurricane Resistant Construction

Based on the 2006 International Building Code® (IBC®) and the 2006 International Residential Code® (IRC®)

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Course Description

This 90 minute seminar covers code requirements for light-frame construction in areas of high wind and flood. It gives participants the knowledge needed to understand the impact of high winds, waves, and flooding on structures.

In addition, it provides information on the prescriptive high wind and flood requirements found in the 2006 IBC and 2006 IRC.

Goal

Participants will be able to describe the damage caused to new light-frame construction by floods and high winds, and to apply requirements of the IBC and IRC to prevent such damage.

Objectives

Upon completion, participants will be better able to:

1. Describe the sources of flooding and the types of damage caused by each.
2. Explain the dynamics of flooding.
3. Identify requirements of the IBC and IRC that prescribe light-frame construction in order to prevent flood damage.

Objectives

Upon completion, participants will be better able to:

4. Describe damage caused by high winds.
5. Identify requirements of the IBC and IRC to increase levels of construction in high wind areas.
6. Explain the elements of wind-resistant construction.

Module 1: Flooding—Introduction

Floods occur when rainfall occurs so intensely that the ground cannot absorb it and/or streams and rivers cannot carry the runoff away within their banks.

Module 1: Flooding—Introduction

Flash floods are floods that develop very rapidly, within a few minutes to a few hours, usually in association with sustained heavy thunderstorm rain over the area.

Module 1: Flooding—Introduction

Flash floods can also result from the breaking of levees or ice or debris jams.

Levee breach

House caught in an ice jam

Module 1: Flooding—Introduction

Slower-developing flooding occurs on larger streams and rivers from large areas of sustained heavy rain and/or snowmelt.

Module 1: Flooding—Introduction

Water moving at 8 miles per hour exerts the same force as the winds in an F5 tornado.

A foot of fast-flowing water can push a moving vehicle, and water that rises to the underbody of the vehicle can sweep it downstream.

Module 1: Flooding—Introduction

Structures in zones susceptible to moving water should be above flood level.

Structures can avoid flood water

- by elevation or isolation (water-tight perimeters, dikes, and levees), or
- Be structurally reinforced by flood-proofing techniques that control the entry and exit of floodwaters.

Module 1: Flooding—Dynamics of Flooding

Flood waters and related damage

Flooding is the most common of natural hazards:

- People underestimate the force and power of water.
- Six inches of fast-moving water can knock a person off his feet.
- Water 24 inches deep can carry away an automobile.
- Flooding causes more than $2 billion in property damage annually.

Module 1: Flooding—Dynamics of Flooding

Saturation

Saturation occurs when an object can not absorb or incorporate any additional material (such as when ground can not absorb additional water). Building design must address the effects of the water in the soil when it becomes saturated.

These effects include buoyancy and lateral forces, referred to as "hydrostatic" pressures or forces.

Module 1: Flooding—Dynamics of Flooding

A sloped property with a structure being saturated by flood waters

Module 1: Flooding—Dynamics of Flooding

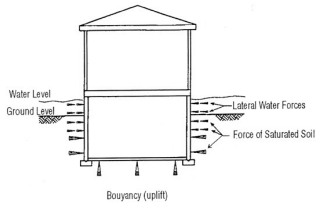
Hydrostatic Force

Hydrostatic force is the pressure exerted by a fluid at equilibrium at a given point within the fluid, due to the force of gravity.

Hydrostatic pressure increases in proportion to the depth measured from the surface because of the increasing weight of the fluid exerting downward force from above.

Module 1: Flooding—Dynamics of Flooding

Hydrostatic Pressures By Water Depth	
Height (H) Water Depth	Ph (pounds/ square foot)
1	62.4
2	124.8
3	182.2
4	249.6
5	312.0
6	374.4
7	436.8
8	499.2
9	561.6
10	624.0



Hydrostatic pressure on a structure below grade

Module 1: Flooding—Dynamics of Flooding

Storm Surge

Storm surge is an offshore rise of water associated with a low-pressure weather system, typically a tropical cyclone.

Storm surge is caused primarily by high winds pushing on the ocean's surface.

Wave-impact-related damage can range from retaining wall failure to the total collapse of a multi-story structure.

Module 1: Flooding—Dynamics of Flooding

Damage from a storm surge

Module 1: Flooding—Dynamics of Flooding

Saffir-Simpson Scale for Storm Surge

The Saffir-Simpson Hurricane Scale is a 1-5 rating based on a hurricane's present intensity. It is used to estimate the potential property damage and flooding expected along the coast from a hurricane landfall.

Wind speed is the determining factor in the scale.

All winds on the scale use the US 1-minute average.

Module 1: Flooding—Dynamics of Flooding

Saffir-Simpson Scale			
Category	Wind (mph)	Pressure (inches)	Surge (feet)
1	74-95	>28.94	4-5
2	96-110	28.50-28.93	6-8
3	111-130	27.91-28.49	9-12
4	131-155	27.17-27.90	13-18
5	>155	<27.16	>18

Module 1: Flooding—Dynamics of Flooding

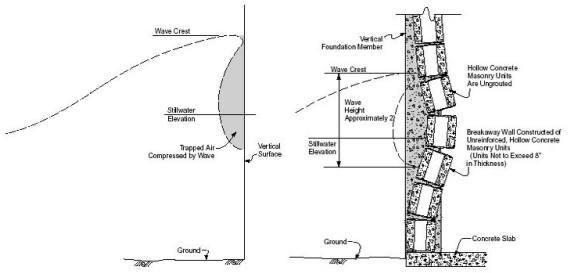
Wave Impact

Effects of wave action include:

- Waves lifting a structure off its foundation (uplift forces), and
- Waves breaking against the structure

Either of these can cause overturning or collapse of the structure.

Module 1: Flooding—Dynamics of Flooding



Damage caused by compressed air within a wave impact

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Flood

Highly susceptible:

- Hydrostatic pressure to emptied or drained pools and spas.
- Drywall installed on a lower level of a structure in a flood prone area.
- Poorly consolidated soils causing scour and loss of support to the structure's foundation.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Flood

Moderately susceptible:

- Docks having the deck and support members damaged by debris in the flood.
- Seawalls damaged from excess force water on the front side of the wall and loss of retained soil on the backside of the wall.
- Damage to wood frame construction from debris in the water and the saturation of the wood in the water.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Flood

Unlikely susceptible:

- Roof components due to the roofs being high enough that the floodwaters are not able to reach them.
- Reinforced masonry construction due to structure being able to withstand debris impacts.
- If the structure is designed to break away during a flood.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Storm Surge

Highly susceptible:

- Wood frame and unreinforced masonry construction act as seawalls with no retained soil on the backside during a storm surge and eventually will fail.
- Store front glass walls due to the pressure on the glass and how the glass is installed in the frame.
- Poorly consolidated soils causing scour and loss of support to the structure's foundation.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Storm Surge

Moderately susceptible:

- Docks having the deck and support members damaged from debris in the flood.
- Seawalls damaged from excess force water on front side of the wall and loss of retained soil on the backside of the wall.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Storm Surge

Moderately susceptible: *(continued)*

- Reinforced masonry construction damaged from constant pounding of the waves and the air pressure trapped within the waves.
- Bridges due to scour to bridge abutments and/or the surge lifting the bridge off its columns.
- Roads could be damaged by scour, being submerged, or being covered by debris and soils.

Module 1: Flooding—Dynamics of Flooding

Susceptible Systems and Components—Storm Surge

Unlikely susceptible:

- Reinforced concrete, if constructed properly, can withstand a good amount of wave action and debris impact.

Module 2: High Wind—Introduction

High wind refers to:

- Sustained wind speeds of 40 miles per hour or greater lasting for 1 hour or longer, or
- Winds of 58 miles per hour or greater for any duration.

Module 2: High Wind—Introduction

The intensity of high winds is expressed in terms of categories that relate wind speeds and potential damage.

A Category 4 hurricane on the Saffir-Simpson Hurricane Scale can cause 100 times the damage of a Category 1 storm.

Module 2: High Wind—General Characteristics of Wind

General characteristics of wind include:

- Winds seeks its own level.
  - Moves from high-pressure zones to low-pressure zones.
  - Speeds up around corners and across roof ridges.
  - Pressure decreases (to negative values) as it speeds up.

Module 2: High Wind—General Characteristics of Wind

General characteristics of wind include: *(continued)*

- The velocity of moving air fluctuates.
  - The rate at which air moves is less in areas that present obstructions, such as cities, and mountainous terrain.
  - The rate at which air moves is less when it is closer to the ground, but he rate is subject to more fluctuation.
  - The rate at which air moves is higher when it is farther from the ground, and the rate is subject to less fluctuation.

Module 2: High Wind—General Characteristics of Wind

General characteristics of wind include: *(continued)*

- Behavior of air over water.
  - Moves with high speed close to the surface, due to lack of friction.
  - Total rate of speed does not change much.
  - Pushes surface water along in front of the moving air mass (producing a storm surge).

Module 2: High Wind—General Characteristics of Wind

General characteristics of wind include: *(continued)*

- Air has mass.
  - The pressure exerted by moving air is related to the mass of the air itself.
  - The pressure exerted by moving air is related to the velocity squared of the moving air.

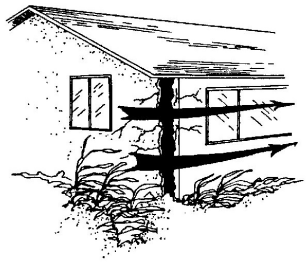
$$\text{Pressure} = \text{Mass} \times \text{Velocity}^2$$

Module 2: High Wind—External Pressure

A structure generally receives wind loading from more than one surface. Wall loads can be identified by location of the wall in reference to the wind direction, windward side, leeward side, or a side.

There are corner loads, as well.

Module 2: High Wind—External Pressure

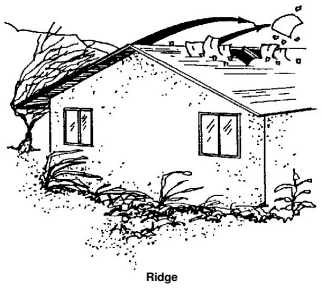


Wall-Corner

Module 2: High Wind—External Pressure

Eave

Module 2: High Wind—External Pressure



Ridge

Module 2: High Wind—External Pressure

Roof-Corner

Module 2: High Wind—External Pressure

There are multiple types of loads that are applied to roofs:

- Flat roof loading
- Low slope roof loading
- High slope roof loading
- Overhang and ridge loading
- Corner overhang loading

Module 2: High Wind—Internal Pressure

Internal pressure damage can result from a failure of a structural component, including:

- Internal wall pressures from a windward or leeward opening failure.
- Internal roof pressures from a windward or leeward opening failure.

Module 2: High Wind—Internal Pressure

Combined wind effects on a structure can result from a failure of multiple structural components, including:

- Combination roof loading from windward opening failures.
- Combined side wall loading from windward opening failures.
- Combined leeward wall loading from windward opening failures.

Module 2: High Wind—Internal Pressure

- Combined windward wall loading from windward opening failures.
- Combined loading on roof from leeward opening failures.
- Combined wall loading from leeward opening failures.
- Combined wall loading from sidewall opening failures.

Module 2: High Wind—Internal Pressure

The combined pressure on a structure is calculated by the equation:

$$(GC_P) - (GC_{pi})/(\text{pounds/foot}^2)$$

Where:

GC_P = External pressure coefficient

GC_{pi} = Internal pressure coefficient

Module 2: High Wind—Impact Forces and Related Damage

Impacts on the structure by other objects, borne or caused by high winds, include:

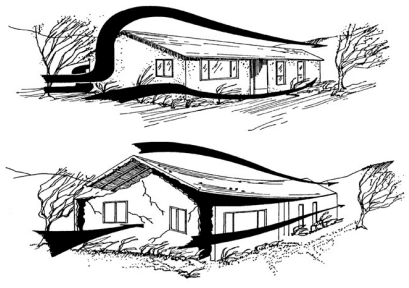
- Impacts from trees
- Impacts from adjacent structures
- Impact by wind-borne debris

A stone carried by high wind can have the same effect on a structure as a shotgun blast.

Module 2: High Wind—Impact Forces and Related Damage

Tree impact on a structure due to high winds

Module 2: High Wind—Impact Forces and Related Damage



Wind-borne debris impact damage

Module 2: High Wind—Saffir-Simpson Scale for Wind

Saffir-Simpson Scale			
Category	Wind (mph)	Pressure (inches)	Surge (feet)
1	74-95	>28.94	4-5
2	96-110	28.50-28.93	6-8
3	111-130	27.91-28.49	9-12
4	131-155	27.17-27.90	13-18
5	>155	<27.16	>18

Module 2: High Wind

Susceptible Systems and Components—High-wind Event

Highly susceptible:

- Aluminum and screen enclosures due to trapping debris. Once the wind can not penetrate the screen, it can become wind-borne very easily.
- Tile and flat roof systems, if not installed with extreme care, will become flying debris and, if the structure below is not protected, water intrusion can become an issue.

Module 2: High Wind

Susceptible Systems and Components—High-wind Event

Moderately susceptible:

- Larger windows and garage doors, if not properly covered or reinforced, can create a failure in the main wind-force-resisting system and pressures within the structure can damage the remaining portion of the structure.
- Gable ends can blow in or be pushed out and the roof system can come flying off.

Module 2: High Wind

Susceptible Systems and Components—High-wind Event

Moderately susceptible: *(continued)*

- Carports are open on all sides or at least one side and can be a victim of internal pressure or roof pressure and can potentially come apart.
- Aged/deteriorated wood-frame construction is usually not anchored properly and/or has loss of section and can fail more readily than new wood-frame construction.

Module 2: High Wind

Susceptible Systems and Components—High-wind Event

Unlikely susceptible:

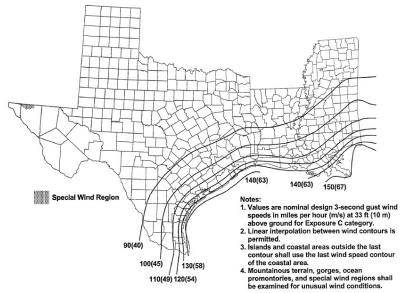
- Docks and seawalls due to how low they are, can be damaged by water or debris.
- Reinforced masonry construction, if constructed properly, can withstand a substantial wind event.

Module 2: High Wind

Wind-borne Debris Regions

The IBC and IRC define wind-borne debris regions as areas within hurricane-prone regions within one mile of the coastal mean high water line where the basic wind speed is 110 miles per hour or greater; or where the basic wind speed is equal to or greater than 120 miles per hour; or Hawaii.

Module 2: High Wind



IBC Figure 1609—Basic Wind Speed

Module 3: Overview of IRC Wind and Flood Provisions

These are sections of the *International Residential Code* (IRC) that should be considered when designing residential structures for wind and flood regions. These sections will assist homebuilders in the construction of homes resistant to wind and flood damage.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.1 Application. Buildings and structures, and all parts thereof, shall be constructed to safely support all loads, including dead loads, live loads, roof loads, flood loads, snow loads, wind loads and seismic loads as prescribed by this code. The construction of buildings and structures in accordance with the provisions of this code shall result in a system that provides a complete load path that meets all requirements for the transfer of all loads from their point of origin through the load-resisting elements to the foundation. Buildings and structures constructed as prescribed by this code are deemed to comply with the requirements of this section.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.1.1 Alternative provisions. As an alternative to the requirements in Section 301.1 the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards the design shall comply with the *International Building Code*.

1. American Forest and Paper Association (AF&PA) *Wood Frame Construction Manual* (WFCM).
2. American Iron and Steel Institute (AISI) *Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings (COFS/PM) with Supplement to Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings.*

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.1.2 Construction systems. The requirements of this code are based on platform and balloon-frame construction for light-frame buildings. The requirements for concrete and masonry buildings are based on a balloon framing system. Other framing systems must have equivalent detailing to ensure force transfer, continuity and compatible deformations.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.1.3 Engineered design. When a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance the *International Building Code* is permitted for all buildings and structures, and parts thereof, included in the scope of this code.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2 Climatic and geographic design criteria. Buildings shall be constructed in accordance with the provisions of this code as limited by the provisions of this section. Additional criteria shall be established by the local jurisdiction and set forth in Table R301.2(1).

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2.1 Wind limitations. Buildings and portion thereof shall be limited by wind speed, as defined in Table R301.2(1) and construction methods in accordance with this code. Basic wind speeds shall be determined from Figure R301.2(4). Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where loads for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors are not otherwise specified, the loads listed in Table R301.2(2) adjusted for height and exposure using Table R301.2(3) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors. Asphalt shingles shall be designed for win speeds in accordance with Section R905.2.6.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2.1.1 Design criteria. Construction in regions where the basic wind speeds from Figure R301.2(4) equal or exceed 100 miles per hour (45 m/s) in hurricane-prone regions, or 110 miles per hour (49 m/s) elsewhere, shall be designed in accordance with one of the following:

1. American Forest and Paper Association (AF&PA) *Wood Frame Construction Manual for One- and Two-Family Dwellings*(WFCM); or

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2.1.2 Protection of openings. Windows in buildings located in windborne debris regions shall have glazed openings protected from windborne debris. Glazed opening protection for windborne debris shall meet the requirements of the Large Missile Test of an approved impact resisting standard or ASTM E 1996 and ASTM E 1886 referenced therein.

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2.1.4 Exposure category. For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories:

Module 3: Overview of IRC Wind and Flood Provisions

Building Planning—Design Criteria

Section R301.2.1.4 (continued)

1. Exposure A. Large city centers with at least 50 percent of the buildings having a height in excess of 70 feet (21 336 mm). Use of this exposure category shall be limited to those areas for which terrain representative of Exposure A prevails in the upwind direction for a distance of at least 0.5 mile (0.8 km) or 10 times the height of the building or other structure, whichever is greater. Possible channeling effects or increased velocity pressures due to the building or structure being located in the wake of adjacent buildings shall be taken into account.

Building Planning—Design Criteria

Section R301.2.1.4 (continued)

2. Exposure B. Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.

Building Planning—Design Criteria

Section R301.2.1.4 (continued)

3. Exposure C. Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet 99144 mm) extending more then 1,500 feet (457 m) from the building site in any quadrant. This exposure shall also apply to any building location within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet (183 m). This category includes flat open country, grasslands and shorelines in hurricane prone regions.

Building Planning—Design Criteria

Section R301.2.1.4 (continued)

4. Exposure D. Flat, unobstructed areas exposed to wind lowing over open water (excluding shorelines in hurricane prone regions) for a distance of at least 1 mile (1.61 km). Shorelines in Exposure D include inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska. This exposure shall apply one to those buildings and other structures exposed to the wind coming from over the water. Exposure D extends inland from the shoreline a distance of 1,500 feet (457 m) or 10 times the height of the building or structure, whichever is greater.

Glazing

Section R308.1 Identification. Except as indicated in Section R308.1.1 each pane of glazing installed in hazardous locations as defined in Section R308.4 shall be provided with a manufacturer's designation specifying who applied the designation, designating the type of glass and the safety glazing standard with which it complies which is visible in the final installation. The designation shall be acid etched, sandblasted, ceramic-fired, laser etched, embossed, or be of a type which once applied cannot be removed without being destroyed. A label shall be permitted in lieu of the manufacturer's designation.

Garages and Carports

Section R309.5 Flood hazard areas. For buildings located in flood hazard areas as established by Table R301.2(1), garage floors shall be:

1. Elevated to or above the design flood elevation as determined in Section R324; or
2. Located below the design flood elevation provided they are at or above grade on all sides, are used solely for parking, building access, or storage, meet the requirements of Section R324, and are otherwise constructed in accordance with this code.

Means of Egress

Section R311.2.1 Attachment. Required exterior egress balconies, exterior exit stairways and similar means of egress components shall be positively anchored to the primary structure to resist both vertical and lateral forces. Such attachment shall not be accomplished by use of toenails or nails subject to withdrawal.

Module 3: Overview of IRC Wind and Flood Provisions

Flood-resistant Construction

Section R324.1.1 Structural systems. All structural systems of all buildings and structures shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses from flooding equal to the design flood elevation.

Module 3: Overview of IRC Wind and Flood Provisions

Flood-resistant Construction

Section R324.1.2 Flood-resistant construction. All buildings and structures erected in areas prone to flooding shall be constructed by methods and practices that minimize flood damage.

Module 3: Overview of IRC Wind and Flood Provisions

Under-floor Space

Section R408.7 Flood resistance. For buildings located in areas prone to flooding as established in Table R301.2(1):

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R324.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level.

Exception: Under-floor spaces that meet the requirements of FEMA/FIA TB 11.1.

Module 3: Overview of IRC Wind and Flood Provisions

Exterior Windows and Glass Doors

Section R613.7 Wind-borne debris protection. Protection of exterior windows and glass doors in buildings located in wind-borne debris regions shall be in accordance with Section R301.2.1.2.

Module 3: Overview of IRC Wind and Flood Provisions

Exterior Windows and Glass Doors

Section R613.7.1 Fenestration testing and labeling. Fenestration shall be tested by an approved independent laboratory, listed by an approved entity, and bear a label identifying manufacturer, performance characteristics, and approved inspection agency to indicate compliance with the requirements of the following specification:

1. ASTM E 1886 and ASTM E 1996; or
2. AAMA 506.

Module 3: Overview of IRC Wind and Flood Provisions

Exterior Windows and Glass Doors

Section R613.8 Anchorage methods. The methods cited in this section apply only to anchorage of window and glass door assemblies to the main force-resisting system.

Module 3: Overview of IRC Wind and Flood Provisions

Wall Covering—Exterior Covering

Section R703.1 General. Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing as described in Section R703.8. The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a water-resistive barrier behind the exterior veneer as required by Section R703.2 and a means of draining water that enters the assembly to the exterior. Protection against condensation in the exterior wall assembly shall be provided in accordance with Chapter 11 of this code.

Module 3: Overview of IRC Wind and Flood Provisions

Wall Covering—Exterior Covering

Section R703.4 Attachments. Unless specified otherwise, all wall coverings shall be securely fastened in accordance with Table R703.4 or with other approved aluminum, stainless steel, zinc-coated or other approved corrosion-resistive fasteners. Where the basic wind speed per Figure R301.2(4) is 110 miles per hour (49 m/s) or higher, the attachment of wall coverings shall be designed to resist the component and cladding loads specified in Table R301.2(2), adjusted for height and exposure in accordance with Table R301.2(3).

Module 3: Overview of IRC Wind and Flood Provisions

Roof-ceiling Construction—Wood Roof Framing

Section R802.11.1 Uplift resistance. Roof assemblies which are subject to wind uplift pressures of 20 pounds per square foot (960 Pa) or greater shall have roof rafters or trusses attached to their supporting wall assemblies by connections capable of providing the resistance required in Table R802.11. Wind uplift pressures shall be determined using an effective wind area of 100 square feet (9.3 m^2) and Zone 1 in Table R301.2(2), as adjusted for height and exposure per Table R301.2(3). A continuous load path shall be designed to transmit the uplift forces from the rafter or truss ties to the foundation.

Module 3: Overview of IRC Wind and Flood Provisions

Weather Protection

Section R903.2 Flashing. Flashings shall be installed in a manner that prevents moisture from entering the wall and roof through joints in copings, through moisture permeable materials and at intersections with parapet walls and other penetrations through the roof plane.

Module 3: Overview of IRC Wind and Flood Provisions

Weather Protection

Section R903.4 Roof drainage. Unless roofs are sloped to drain over roof edges, roof drains shall be installed at each low point of the roof. Where required for roof drainage, scuppers shall be placed level with the roof surface in a wall or parapet. The scupper shall be located as determined by the roof slope and contributing roof area.

Module 4: Overview of IBC Wind and Flood Provisions

These are sections of the *International Building Code* (IBC) that should be considered when designing commercial structures for wind and flood regions. These sections will assist construction professionals in the construction of buildings resistant to wind and flood damage.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1403.2 Weather protection. Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing, as described in Section 1405.3. The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulation water within the wall assembly by providing a water-resistive barrier behind the exterior veneer, as described in Section 1404.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the exterior wall assembly shall be provided in accordance with the *International Energy Conservation Code*.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1403.5 Flood resistance. For buildings in flood hazard areas as established in Section 1612.3, exterior walls extending below the design flood elevation shall be resistant to water damage. Wood shall be pressure-preservative treated in accordance with AWPA Ul for the species, product and end use using a preservative listed in Section 4 of AWPAU1 or decay-resistant heartwood of redwood, black locust or cedar.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1403.6 Flood resistance for high-velocity wave action areas. For buildings in flood hazard areas subject to high-velocity wave action as established in Section 1612.3, electrical, mechanical and plumbing system components shall not be mounted on or penetrate through exterior walls that are designed to break away under flood loads.

Module 4: Overview of IBC Wind and Flood Provisions

Installation of Wall Coverings

Section 1405.2 Weather protection. Exterior walls shall provide weather protection for the building. The materials of the minimum nominal thickness specified in Table 1405.2 shall be acceptable as approved weather coverings.

Module 4: Overview of IBC Wind and Flood Provisions

Weather Protection

Section 1503.1 General. Roof decks shall be covered with approved roof coverings secured to the building or structure in accordance with the provisions of this chapter. Roof coverings shall be designed, installed and maintained in accordance with this code and the approved manufacturer's instructions such that the roof covering shall serve to protect the building or structure.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1504.1 Wind resistance of roofs. Roof decks and roof coverings shall be designed for wind loads in accordance with Chapter 16 and Sections 1504.2, 1504.3 and 1504.4.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1504.3 Wind resistance of nonballasted roofs. Roof coverings installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the roof deck shall be designed to resist the design wind load pressures for cladding in Chapter 16.

Module 4: Overview of IBC Wind and Flood Provisions

Performance Requirements

Section 1504.3.1 Other roof systems. Roof systems with built-up, modified bitumen, fully adhered or mechanically attached single-ply through fastened metal panel roof systems, and other types of membrane roof coverings shall also be tested in accordance with FM 4450, FM 4470, UL 580 or UL 1897.

Module 4: Overview of IBC Wind and Flood Provisions

Structural Design—General Design Requirements

Section 1604.1 General. Building, structures and parts thereof shall be designed and constructed in accordance with strength design, load and resistance factor design, allowable stress design, empirical design or conventional construction methods, as permitted by the applicable material chapters.

Module 4: Overview of IBC Wind and Flood Provisions

Structural Design—General Design Requirements

Section 1604.2 Strength. Buildings and other structures, and parts thereof, shall be designed and constructed to support safely the factored loads in load combinations defined in this code without exceeding the appropriate strength limit states for the materials of construction.

Module 4: Overview of IBC Wind and Flood Provisions

Wind Loads

Section 1609.1 Applications. Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

Module 4: Overview of IBC Wind and Flood Provisions

Wind Loads

Section 1609.1.1 Determination of wind loads. Wind loads on every building or structure shall be determined in accordance with Chapter 6 of ASCE 7. The type of opening protection required, the basic wind speed and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7.Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

Module 4: Overview of IBC Wind and Flood Provisions

Rain Loads

Section 1611.1 Design rain loads. Each portion of a roof shall be designed to sustain the load of rainwater that will accumulate on it if the primary drainage system for that portion is blocked plus the uniform load caused by water that rises above the inlet of the secondary drainage system at its design flow.

Module 4: Overview of IBC Wind and Flood Provisions

Flood Loads

Section 1612.1 General. Within flood hazard areas as established in Section 1612.3, all new construction of buildings, structures and portions of buildings and structures, including substantial improvement and restoration of substantial damage to buildings and structures, shall be designed and constructed to resist the effects of flood hazards and flood loads. For buildings that are located in more than one flood hazard area, the provisions associated with the most restrictive flood hazard area shall apply.

Module 5: 2009 New Requirements—Introduction

Introduction to the new standards

1. ICC 600-2008: Standard for Residential Construction in High Wind Regions.
2. ICC/NSSA 500-2008: Design and Construction of Storm Shelters

Module 5: 2009 New Requirements—Introduction

Introduction to the new standards

The 2006 IBC and IRC reference optional prescriptive design standards for construction in high-wind regions. A long-recognized document providing practical designs for residential structures in high-wind areas is the *Southern Building Code Congress International Standard for Hurricane Resistant Residential Construction* (SBCCI-SSTD 10).

A limitation of the SBCCI-SSTD 10 standard is that it is not correlated to the International Codes. The ICC employed the American National Standards Institute (ANSI) process to create the ICC 600-2008 standard, replacing the obsolete SBCI-SSTD 10.

Module 5: 2009 New Requirements—Introduction

Introduction to the new standards

In addition to the ICC 600-2008 standard, another new standard was created to address the design and construction of storm shelters. The ICC developed the ICC/NSSA Standard for the Design and Construction of Storm Shelters in cooperation with the National Storm Shelter Association, following the ANSI approval process.

Both of these new standards are included in the 2009 editions of the International Codes.

Module 5: 2009 New Requirements—ICC 600-2008

ICC 600-2008: Standard for Residential Construction in High Wind Regions

The ICC 600-2008:

- Is an update to ICC Standard SSTD 10-99, Standard for Hurricane Resistant Residential Construction.
- Provides prescriptive details for construction of light-frame, masonry or concrete buildings used for residences in high-wind regions.
- Consists of a set of specifications that are consistent with the *International Building Code* and ASCE 7 wind loads, wind speed maps and conventions.

Module 5: 2009 New Requirements—ICC 600-2008

ICC 600-2008 Design Assumptions

Foundation Design Assumptions

- Foundations are continuous.
- Buildings are a maximum of three stories in height.
- Wind speeds are a maximum of 150 miles per hour, Exposure C.
- Wind loads are based on the ASCE 7-05 analytical procedure for low-rise buildings.

Module 5: 2009 New Requirements—ICC 600-2008

ICC 600-2008 Design Assumptions

Foundation Design Assumptions *(continued)*

- Increased end zone loads are used, but no torsional load cases.
- Calculations do not include increases due to topographic factors.
- Calculations are based only on perpendicular-to-ridge loading directions.
- ASCE allowable stress design (ASD) basic load combinations are used.

Module 5: 2009 New Requirements—ICC 600-2008

ICC 600-2008 Design Assumptions

Foundation Analysis Model

- Is a global overturning model.
- Assumes that the supported building can act as a rigid box, and permits calculation of the weight required to resist overturning of the box (rolling over as a unit).

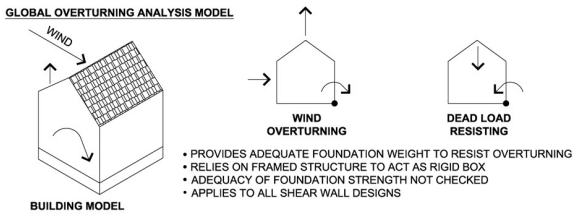
Module 5: 2009 New Requirements—ICC 600-2008

ICC 600-2008 Design Assumptions

Foundation Analysis Model *(continued)*

- Generally produces a foundation size greater than required by SSTD 10 in the past, but smaller than might be determined by a detailed engineering load path analysis.
- Out of three possible levels of analysis, this intermediate level was chose as a compromise.

Module 5: 2009 New Requirements—ICC 600-2008



Foundation Analysis Model, Global Overturning

Module 5: 2009 New Requirements—ICC 600-2008

Organization of Standard ICC 600-2008

The standard is organized into the following chapters:

- **Chapter 1 General Requirements:** This chapter provides the basic loads and design parameters to be applied to the various tables and figures throughout the rest of the standard.
- **Chapter 2 Buildings with Concrete or Masonry Exterior Walls:** This chapter provides prescriptive details for concrete and masonry buildings.

Module 5: 2009 New Requirements—ICC 600-2008

Organization of Standard ICC 600-2008

- **Chapter 3 Buildings with Wood or Steel Light-framed Exterior Walls:** This chapter provides prescriptive details for light-framed wood and steel construction. The standard refers to the AISI Standard COFS/PM-2006 Standard for Cold-Formed Steel—Prescriptive Method for One- and Two-Family Dwellings for light gage steel, and AF&PA Wood Frame Construction Manual for light-framed wood construction. Prescriptive details for the framing of building exterior walls are contained in these standards.

Module 5: 2009 New Requirements—ICC 600-2008

Organization of Standard ICC 600-2008

- **Chapter 4 Combined Exterior Wall Construction:** This chapter deals with commonly used combinations of materials used for exterior walls, such as wood frame walls above masonry or brick walls.

Module 5: 2009 New Requirements—ICC 600-2008

Organization of Standard ICC 600-2008

- **Chapter 5 Roof Assemblies:** This chapter deals with roof assemblies, including roof decks and roof coverings.
- **Chapter 6 Fenestration:** This chapter deals with windows and doors.
- **Chapter 7 Exterior Wall Covering:** This chapter deals with exterior wall covering.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

ICC/NSSA 500-2008: Standard for the Design and Construction of Storm Shelters

The ICC/NSSA 500-2008:

- Was developed by the ICC and the National Storm Shelter Association.
- Published in July, 2008.
- Provides minimum design and construction requirements for storm shelters that provide a safe refuge from storms that produce high winds, hurricanes, and tornadoes.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

The ICC/NSSA 500-2008 provides:

- Design requirements
- The main wind-resisting structural system
- Components and cladding for the shelters
- Basic occupant life safety and health requirements, including means of egress, lighting, sanitation, ventilation, fire safety, and minimum required floor space for occupants.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Hurricane or Tornado Shelters

The standard makes a distinction between shelters used for hurricanes versus shelters used for tornadoes based on the duration of the storm:

- Tornadoes are short-lived storms, so the shelter need to provide for occupants for a couple of hours only;
- Hurricanes can remain at strength for many hours, neccesitating shelter for a longer period of time.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Hurricane or Tornado Shelters

Base durations are:

- Tornado shelters: 2 hours
- Hurricane shelters: 24 hours

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Hurricane or Tornado Shelters

Requirements differentiating hurricane and tornado shelters include:

- Occupant density.
- Sanitation.
- Water supply.
- Ventilation.
- Emergency power.
- Size and speed of flying debris.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Community or Residential Shelters

The standard also makes a distinction between community versus residential shelters in that people using residential shelters are more familiar with each other and can tolerate closer spacing conditions for the occupants.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Access and Means of Egress

Access and means of egress issues covered include:

- Number of doorways.
- Emergency escape.
- Accessibility.
- Access ladder.
- Locks and latches.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Ventilation

Minimum ventilation openings are required for all types of storm shelters, in accordance with Table 702.1.1 or 703.1 of the standard, depending on whether the shelter is for tornadoes or hurricanes.

Hurricane shelters are also required to have mechanical ventilation, in accordance with the applicable code for the occupant load.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters

Sanitation

Tables 702.2 and 703.2 provide minimum sanitation facilities.

Potable Water and Wastewater Storage

The required minimum supply of drinking water and wastewater storage is provided in Table 703.3.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Other Essential Features

Other essential features required in tornado storm shelters include:

- Fire extinguishers.
- First aid kit in shelters with greater than 50 occupant load.
- Emergency lighting in community shelters.

Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Other Essential Features

Other essential features required in hurricane storm shelters include:

- Fire extinguishers.
- First aid kit in all community hurricane shelters.
- Emergency lighting.
- Standby lighting.
- Standby power.

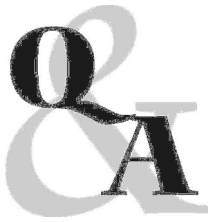
Module 5: 2009 New Requirements—ICC/NSSA 500-2008

Types of Storm Shelters—Structural Issues

The structural issues that the storm shelter committee tackled include:

1. The wind loads that should be used; and
2. The size and velocity of flying debris.

Questions and Answers



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